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NOTES ON GEOGRAPHIC DISTRIBUTION

Primates, Pitheciidae, *Callicebus coimbrai* Kobayashi and Langguth, 1999: New localities for an endangered titi monkey in eastern Sergipe, Brazil

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ABSTRACT: Coimbra-Filho's titi monkey, *Callicebus coimbrai* Kobayashi and Langguth, 1999, appears to be endemic to the northern Atlantic Forest, south of the lower São Francisco River in east of the state of Sergipe and north-east of the state of Bahia. This study presents 13 new records of the occurrence of the species in the São Francisco and Japaratuba basins of eastern Sergipe, extending its range in the state over a distance of some 40 km. This represents an important advance in the known range and total number of populations of this endangered primate.

Coimbra-Filho's titi, *Callicebus coimbrai* Kobayashi and Langguth, 1999, was discovered in Pacatuba in the east of the state of Sergipe, and was originally assumed to occur within a restricted area of the Atlantic Forest in this state (Kobayashi and Langguth, 1999). A number of surveys in Sergipe (Jerusalinsky *et al*. 2006) and the neighboring state of Bahia (Printes *et al.* 2011; Sousa *et al*. 2008) have since shown that the species is more widespread, and probably ranges as far south as the Paraguaçu River in the vicinity of Salvador, Bahia. Ongoing ecological monitoring at two sites in Sergipe (*e.g.* Souza-Alves *et al*. 2011) has further expanded our knowledge of the characteristics of the species, although the number of remnant populations and the exact limits of its distribution remain unclear. Expanding the zoogeographic database for *C. coimbrai* is especially important considering that this species is classified as Endangered on the IUCN Red List of Threatened Species (Veiga *et al*. 2008). It is threatened primarily by habitat loss and fragmentation, which has a direct effect on the number of populations surviving in the wild.

In the present study, we surveyed the lower basin of the São Francisco River (the northern limit of the geographic range of *Callicebus* in eastern Brazil) and the adjacent basin of the Japaratuba River in Sergipe to locate new populations of these titis (Figure 1). The survey took place within the Atlantic Forest domain as defined by IBGE (2004). The primary aim was to locate all the populations remaining in the area demarcated for the study: the municipality of Pacatuba in the east (10°30' S, 36°39' W), to Capela (10°30' S, 37°03' W) in the west, and Canhoba (10°08' S, 36°58' W) in the north. This area encompasses the coastal Atlantic Forest and the neighboring ecotonal zone, known locally as the 'Agreste', on higher terrain (mostly 100–300 m in altitude) to the west. This region has a hot rainy climate with dry summers (Köppen's AS' type), with mean annual rainfall of 800–1200 mm,

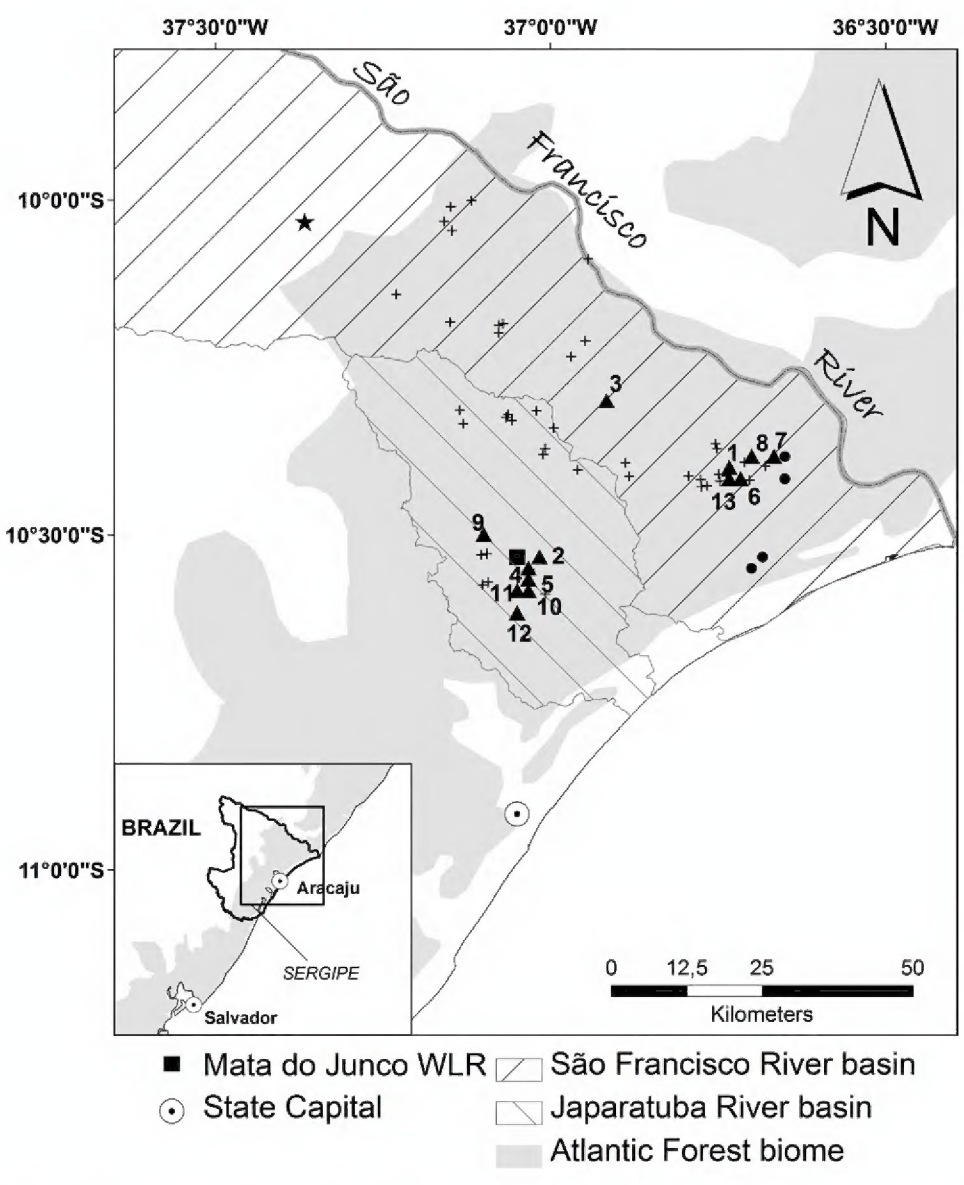

FIGURE 1. Map of the São Francisco and Japaratuba basins in eastern Sergipe, showing the sites surveyed during the present study (▲ = *Callicebus coimbrai* recorded; + = *C. coimbrai* not found), localities at which *C. coimbrai* (●) was recorded in previous studies (Kobayashi and Langguth, 1999; Sousa 2003; Jerusalinsky *et al*. 2006) and the nearest site at which *Callicebus barbarabrownae* was recorded in the São Francisco basin (★) by Marques *et al.* (2013). The sites are numbered as in Table 1.

and mean temperatures of around 26°C, with very little seasonal variation (SEPLAN, 1979).

In the first phase of the survey, we mapped forest patches in recent satellite images (LandSat 5 images from 2006), which could harbor populations of *C. coimbrai*. Only fragments with a minimum area of 20 hectares were included, being the approximate lower limit of home range size in *Callicebus* species (Bicca-Marques and Heymann, 2013). During fieldwork at some sites, however, smaller fragments were also surveyed when the presence of titis was indicated by local residents.

In the second (field) phase, we used of playback surveys to confirm or otherwise the presence of *Callicebus* at each site identified in the first phase. In these surveys we broadcasted a recording of the territorial vocalizations of the genus through a megaphone (CSR Hmp 1503; 20w) in order to elicit a response from titi groups within hearing distance. In most cases, titis react incisively to the potential presence of conspecific intruders by vocalizing and advancing in the direction of the source. This procedure has been used successfully in a number of *Callicebus* surveys at sites throughout South America (Rowe and Martinez 2003; Jerusalinsky *et al*. 2006; Martinez and Wallace 2007; Aldrich *et al*. 2008; Printes *et al*. 2011). Fragments identified by local residents were visited and surveyed by carefully walking existing trails at the edge and interior of the forest, and broadcasting the playback at 15-minute intervals. The surveys were conducted between 06:00–09:00 h and 15:00–17:00 h, when titis are generally more responsive to the playbacks (Melo and Mendes 2000; Soares *et al*. 2011).

If no response was obtained in the initial survey, the site was resurveyed on subsequent days following the same procedure until either the presence of *Callicebus* was confirmed or the site had been surveyed on four separate occasions, when fieldwork was interrupted, and the site was recorded as not having a population of titis. When a response to the playback was obtained, we tried to see them, and also to verify the minimum number of groups within the area, based on simultaneous responses to playbacks or observations in different areas of the forest. A variation of the procedure was used in the Japaratuba basin where the fragments were visited and surveyed independently of reports of the presence of titi occurring in them. In this case, the proximity of fragments surrounding the Mata do Junco Wildlife Refuge (municipality of Capela) was the main criterion for the survey.

Fifty-four localities were visited in the study area between October 2008 and May 2010. We found titi monkeys at 12 of these sites (Table 1). They were observed directly at only five, but their characteristic vocalization is an unmistakable sign of the presence of the genus. Here we consider a minimum of 25 groups observed (including site 2) and a typical group of 3-5 individuals, which means a conservative population estimate of at least 80 animals. For sites at which the animals were not observed directly, the species was considered to be *C. coimbrai* because this is the only member to be known in the region's Atlantic Forest, and all sites were in the general area of its geographic range, as defined by Kobayashi and Langguth (1999) and Jerusalinsky *et al*. (2006). The only other titi in Sergipe is *C. barbarabrownae*, which is restricted to the Caatinga ecosystems in the west of the state (Marques *et al*. 2013).

Site 1: Fazenda Santa Barbara - Mata leste

A small fragment in Fazenda Santa Barbara, composed of typical Atlantic Forest vegetation in moderately advanced stage of succession. This fragment is isolated within a matrix of cattle pasture. The presence of the species has been reported previously, but not confirmed, by Jerusalinsky *et al*. (2006; Mata do Contador 1).

Site 2: Fazenda Cotia

A fragment of Atlantic Forest at an advanced stage of succession, contiguous with the north-eastern extreme of the largest fragment of the Mata do Junco (and thus not a new locality *per se*). It is in a matrix of pasture and sugarcane plantations, and threatened principally by the controlled burn-off of plantations and by urban expansion, being close to the city of Capela and other settlements.

Site 3: Fazenda São Bento Saboeiro

A small fragment of Atlantic Forest at an intermediate stage of succession surrounded by pasture. The principal threats to this fragment's long-term integrity appear to be encroachment by grazing cattle and isolation.

Site 4: Fragment 1

A small fragment of early successional Atlantic Forest separated from the Mata do Junco by the SE-226 highway, and surrounded by pasture and sugarcane plantations. In addition to the threats of agricultural practices, large amounts of domestic waste were observed in the fragment, a source of pollution and probably affecting the recruitment of seedlings.

Site 5: Fragment 2

A small fragment close to the Mata do Junco, with characteristics similar to those of site 4, regarding habitat structure, matrix, and principal threats.

Site 6: Mata da Benedita

A medium-sized fragment of secondary Atlantic Forest at an advanced stage of regeneration, about 5 km from site 1. The soil is mostly sandy, indicating that it may in fact be an arboreal restinga (there are coastal dunes nearby). Surrounded by pastures and settlements, with incursions into the fragment by cattle, being the principal threat to the forest's integrity.

Site 7: Mata da Capivara

A large fragment of Atlantic Forest, one of the largest in Sergipe, characterized by a heterogeneous habitat at varying stages of succession, ranging from bare soil to moderately advanced secondary forest. Less than half the area of the fragment may be appropriate habitat for titis. The forest is surrounded by pasture and settlement plots, which results in some encroachment by cattle.

Site 8: Mata da Maresia

A forest fragment that is smaller than site 6, but better preserved. It is located in a matrix of orchards, sugarcane plantations, and pastures. Pesticides used in the local

orchards may be a specific threat to the forest, in addition to the problem typical of that sort of matrix.

Site 9: Mata do Cipó

A fragment located on the border between the municipalities of Capela and Siriri, formed by forest at an intermediate to advanced stage of succession, in many ways similar to that found at the Mata do Junco Wildlife Refuge. It is surrounded by sugarcane plantations and small subsistence plots. The principal threat to the forest may be the constant incursions by the local population, which suppress the undergrowth and may be reducing recruitment that is damaging in the long term.

Sites 10, 11, 12: Usina Taquari

Also known as Mata da Laranjeira (Fazenda Taquari), Mata do Canto Escuro (Fazenda Araticum) and Mata da Rendeira (Fazenda Araticum), respectively, these three small fragments of Atlantic Forest are located on the property of the Taquari sugar refinery. The habitat at site 10 is early successional, while at sites 11 and 12, it is in intermediate to advanced stage of secondary succession. All three fragments are isolated by sugarcane plantations, which threaten the integrity of the forest through the annual burn-off for harvesting.

Site 13: Assentamento Três Cancelas and Fazenda Santa Barbara (western fragment)

A contiguous forest reserve of the Três Cancelas Agricultural Reform settlement and Santa Barbara ranch. The fragment contains forest at an intermediate stage of succession, with some better-preserved areas of habitat. The general characteristics are similar to sites 1 and 6, which are nearby (between 0.5 and 2 km). Surrounded by pasture, and with widespread signs of selective logging. The presence of the species at Santa Barbara was reported, but not confirmed, by Jerusalinsky et al (2006; Mata do Contador 2). Both sites (1 and 13) may represent areas visited occasionally (or seasonally) by one or two *Callicebus* groups.

While the present study adds significantly to our knowledge of the geographic distribution of the Endangered *C. coimbrai* in the Brazilian north-east, our results confirm the precarious circumstances of most of the remaining populations. Although an area of almost 2,000 hectares of habitat was identified, more than two-thirds of the individual fragments are smaller than 100 ha, and most are relatively degraded and suffer some form of anthropogenic impact. Many of the fragments are also isolated from other areas of natural habitat by relatively ample areas of open habitat, at distances which are prohibitive for the effective dispersal of titis. The most serious threat to all these populations may nevertheless be the lack of official protection (the Mata do Junco Wildlife Refuge in Capela is the only reserve within the study area), and the long-term survival of *C. coimbrai* will ultimately depend on increasing the protection of its remaining habitat and on the development of an effective program of metapopulation management.

Table 1. Details of the sites at which *Callicebus coimbrai* populations were recorded in the Atlantic Forest of the São Francisco and Japaratuba basins in eastern Sergipe, Brazil.

Site	Locality	Municipality	Geographic coordinates	Altitude (m)	Fragment size (ha)	Distance to nearest fragment (km)	Minimum number of groups identified[1]
1	Fazenda Santa Barbara (eastern fragment)	Japoatã	10°24' S, 36°44' W	84	6.7	0.5	1
2	Fazenda Cotia	Capela	10°32' S, 37°01' W	91	52.0	1.4	2
3	Fazenda São Bento Saboeira	Cedro de São João	10°18' S, 36°55' W	43	50.0	1.0	2
4	Fragment 1	Capela	10°33' S, 37°02' W	80	15.6	0.1	1
5	Fragment 2	Capela	10°34' S, 37°02' W	65	4.0	0.1	1
6	Mata da Benedita	Japoatã	10°25' S, 36°43' W	131	242.0	2.2	4*
7	Mata da Capivara	Neópolis	10°23' S, 36°40' W	51	1069.0	1.5	1*
8	Mata da Maresia	Neópolis	10°23' S, 36°42' W	117	219.0	1.5	3*
9	Mata do Cipó	Capela / Siriri	10°30' S, 37°06' W	178	101.0	3.4	2
10	Usina Taquari east fragment	Capela	10°35' S, 37°02' W	143	17.2	1.0	1*
11	Usina Taquari north fragment	Capela	10°35' S, 37°03' W	111	80.8	1.0	3
12	Usina Taquari south fragment	Rosário do Catete	10°37' S, 37°03' W	69	47.0	1.0	2
13	Assentamento Três Cancelas and Fazenda Santa Barbara (western fragment)	Japoatã	10°25' S, 36°44' W	143	48.0	2.2	2*

[1]Minimum number of *C. coimbrai* groups present in the fragment, based on multiple responses to playback broadcasts (observed groups contained 3-5 individuals therefore, we roughly estimate that there are 80 individuals divided in 25 sub-populations);
* Presence of *C. coimbrai* confirmed visually.

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